The Role Of Shoreline And Bottom Type Dynamics In Understanding Barrier Island Vulnerability And Resiliency

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USACE project
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Outline

1. Motivation
2. Study Area
3. Methods
4. Model Setup
5. Results
6. Future work

Motivation

- Barrier islands
  - Protect mainland coast
  - Susceptible to significant storm damage
  - Behavior not well understood

http://coastal.er.usgs.gov/hurricanes/sandy/photo-comparisons/

Focus of study

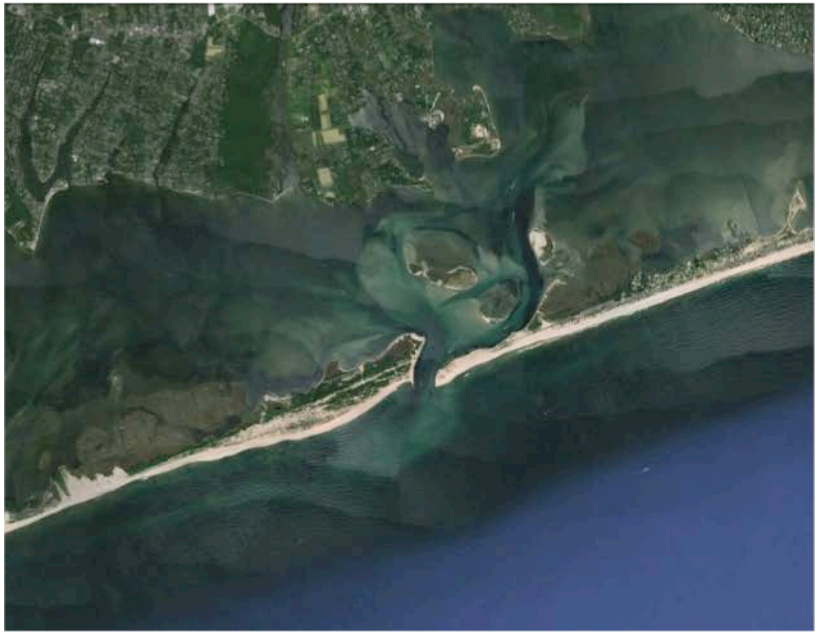
- Quantify dynamics of narrow barrier island systems by integrating remote sensing data with computational models.
  - Investigate effects of bottom types and vegetation to improve understanding of barrier island behavior during storms.
  - Evaluate the utility of Lidar data and multi-spectral data in studying barrier island dynamics and characterizing sediment transport conditions.

Study Area Selection Criteria

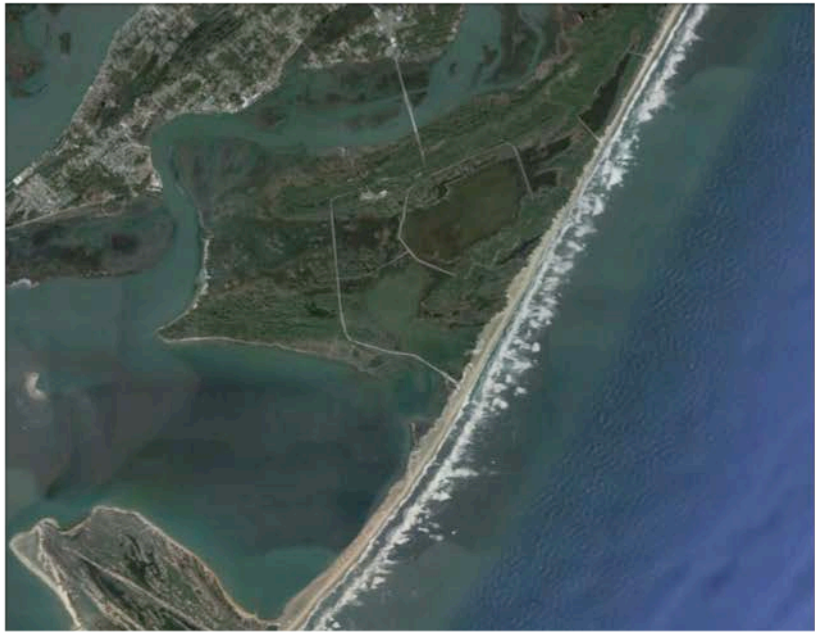
- Narrow island
- Backed by bay
- Must have been overwashed or breached
- Lidar data available
- Storm data available

Study Areas

Moriches Bay, NY



Assateague Island, VA

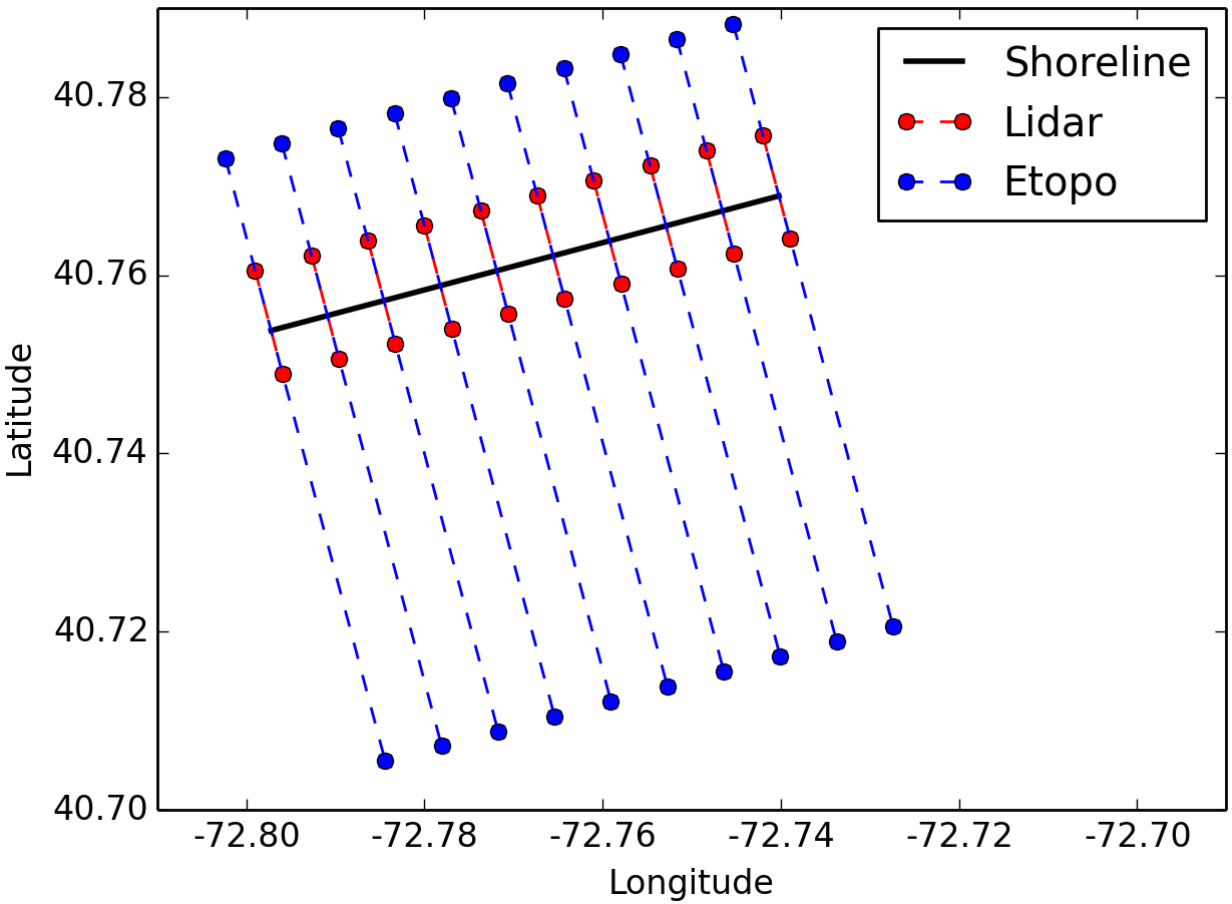


Methods

- XBeach (Roelvink et al., 2009)
  - Models wave propagation and Sediment transport during storms
  - Validated (McCall et al., 2010; van Dongeren et al., 2013)
  - Multiple sediment fractions and layers
- Initial objectives:
  - 1D simulations of idealized profile, varying dune location and vegetation factor

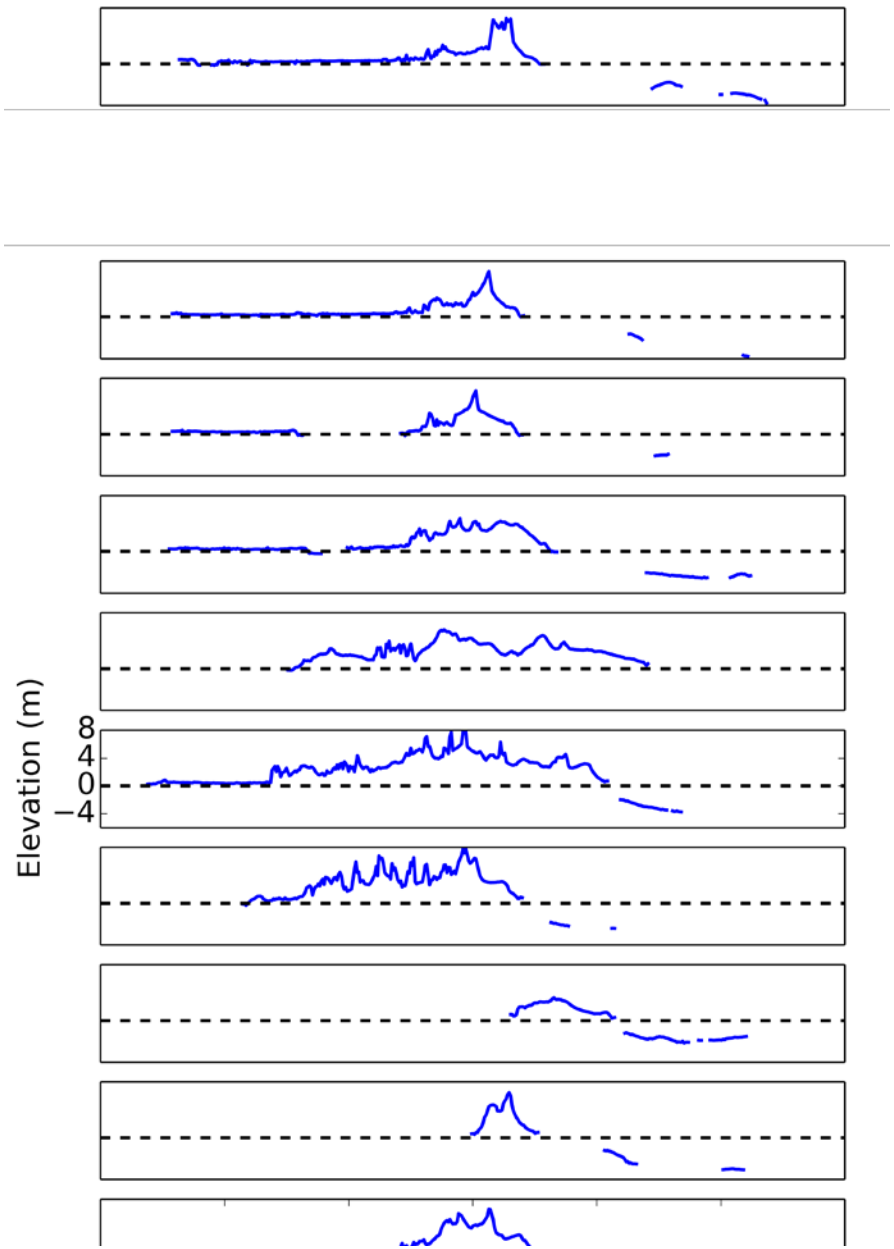
Model Setup

- Grids for Moriches Bay:
  - Profile locations



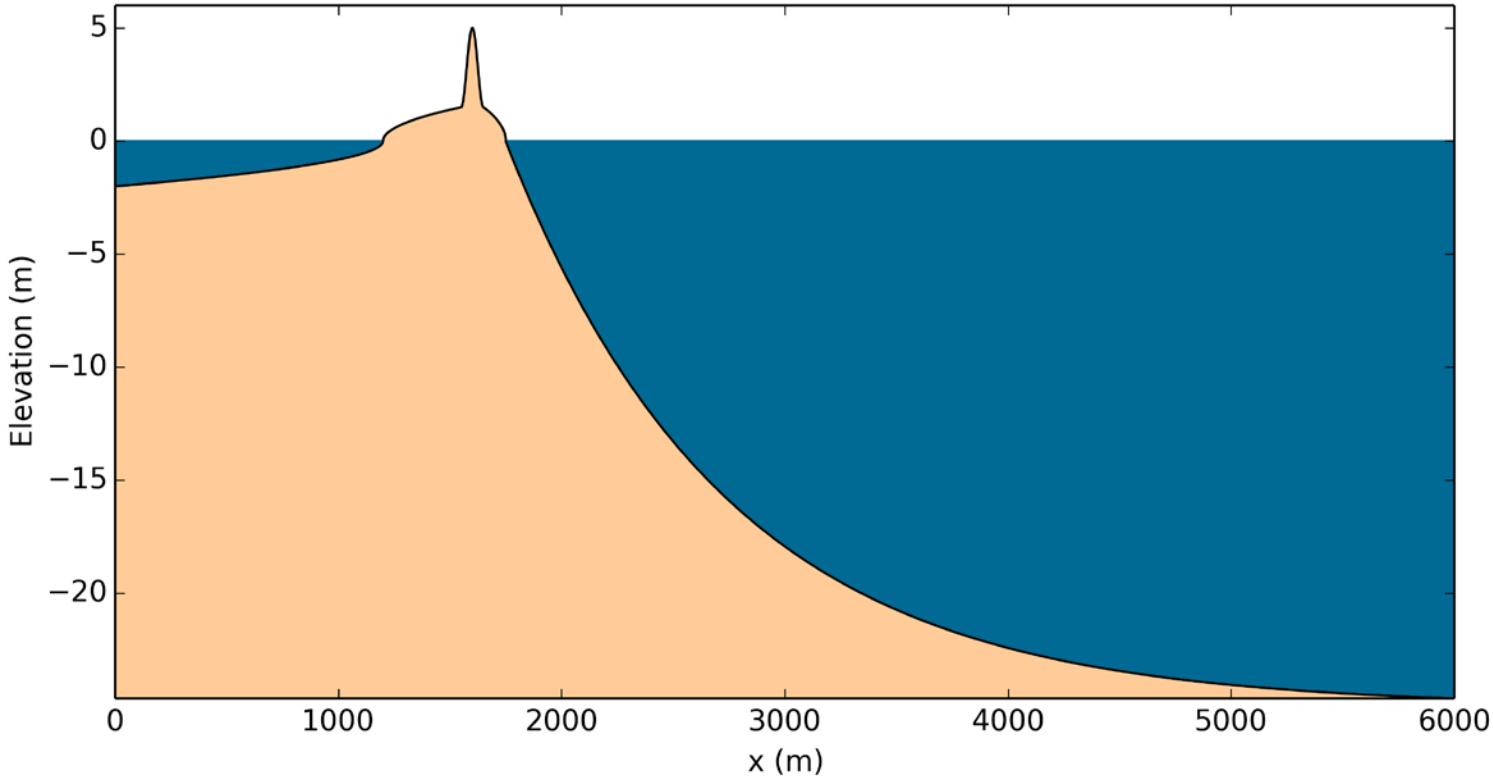
Model Setup

- Grids for Moriches Bay:
  - Topography:
    - Dune height: 4 – 8 m
    - Berm width: 50 – 150 m
    - Total width: 200 – 600 m



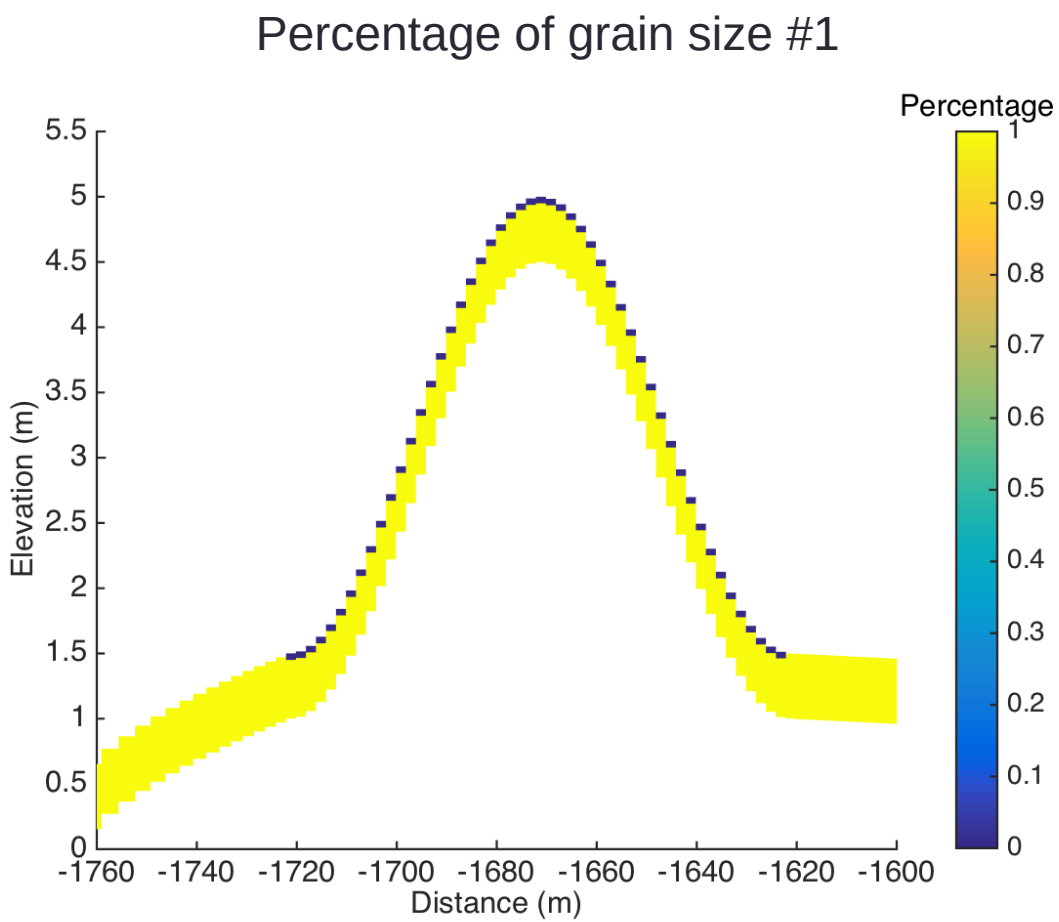
Model Setup

- Grids for Moriches Bay:
  - Idealized combined grid



Model Setup

- Bottom types
  - Sediment layer configurations:
    - Top layer of dune: grass
    - Others: sand



Model Setup

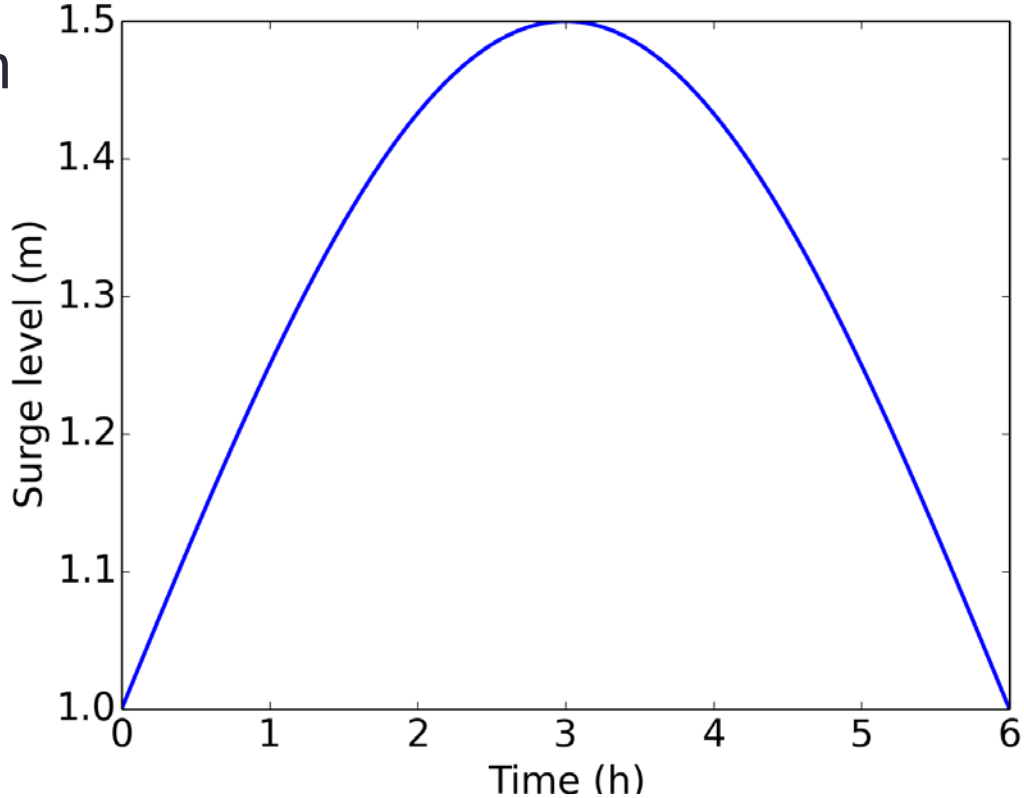
- Bottom types
  - Sedcal parameter:
    - Mobility restriction
    - Scales the equilibrium sediment concentration

$$\frac{\partial hC}{\partial t}+\frac{\partial hCu}{\partial x}+\frac{\partial hCv}{\partial y}+\frac{\partial}{\partial x}\left[D_h h\frac{\partial C}{\partial x}\right]+\frac{\partial}{\partial y}\left[D_h h\frac{\partial C}{\partial y}\right]=\frac{hC_{eq}-hC}{T_s}$$

    - Ranges: 0.0 – 1.0

Model Setup

- Storm wave and surge:
  - Spectral wave height: 8 m
  - Period: 10 s
  - Surge level: 1.0 – 1.5 m
  - Duration: 6 h



Model Setup

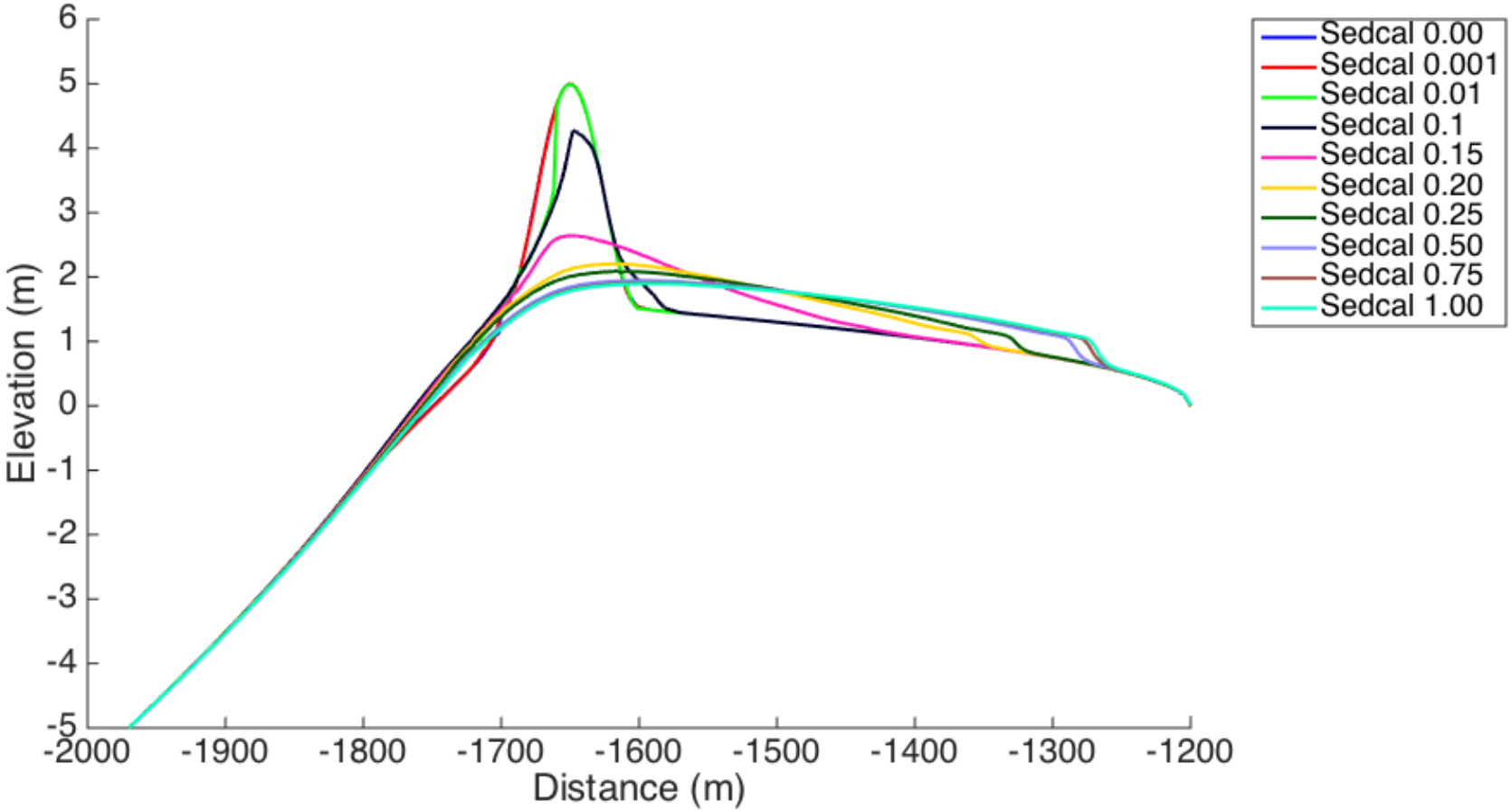
- Parameter space:
  - Sedcal: 0.0, 0.001, 0.01, 0.1, 0.15, 0.20, 0.25, 0.50, 0.75, 1.00
  - Berm width: 50m, 75m, 100m, 125m, 150m
- Fixed parameters:
  - Sediment grain size: 0.2 mm
  - Dune height: 5 m
  - Berm height: 1.5 m
  - Bathymetry

Results

Berm width = 50 m

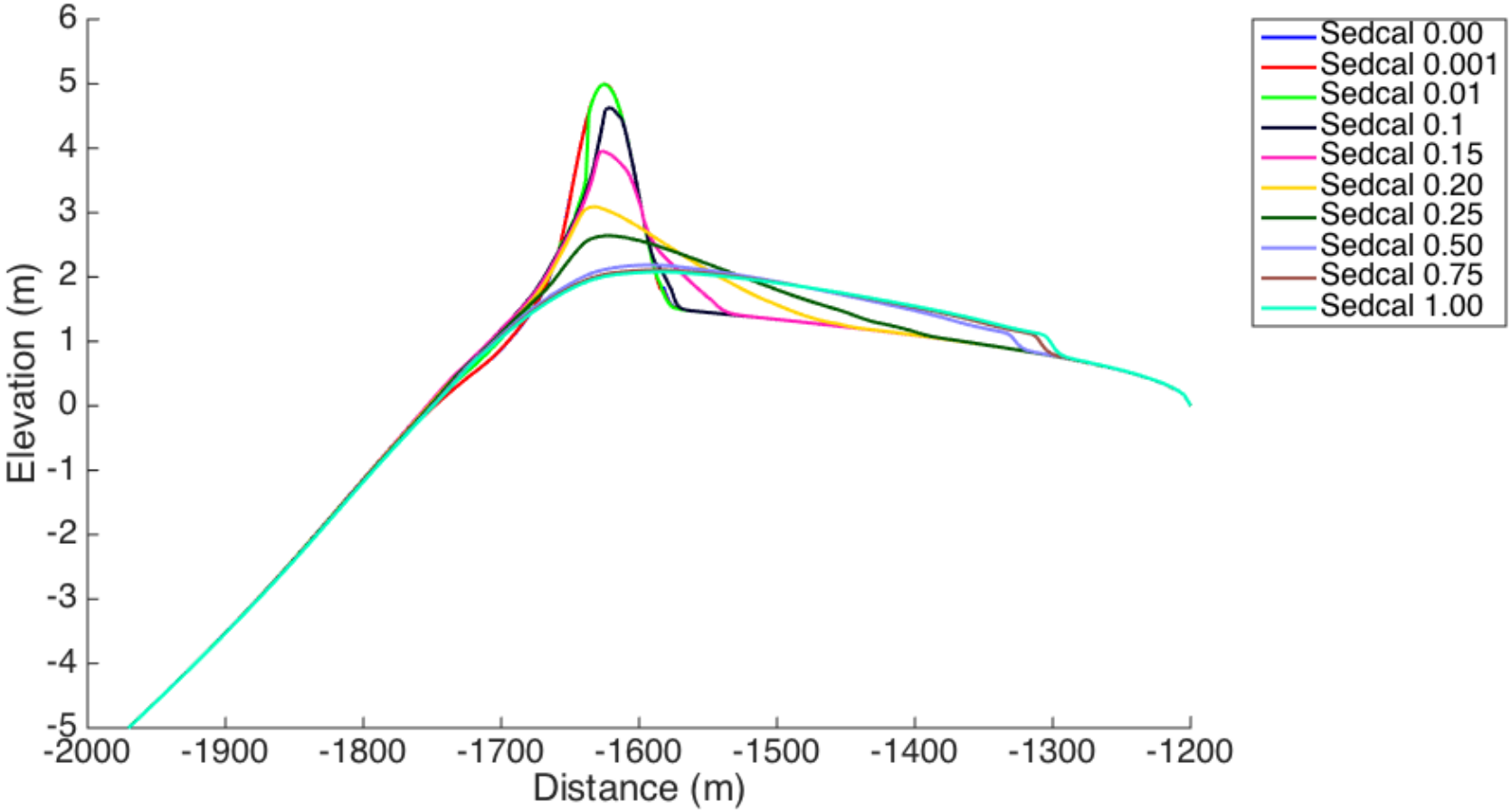
Results

- Berm width 50m:



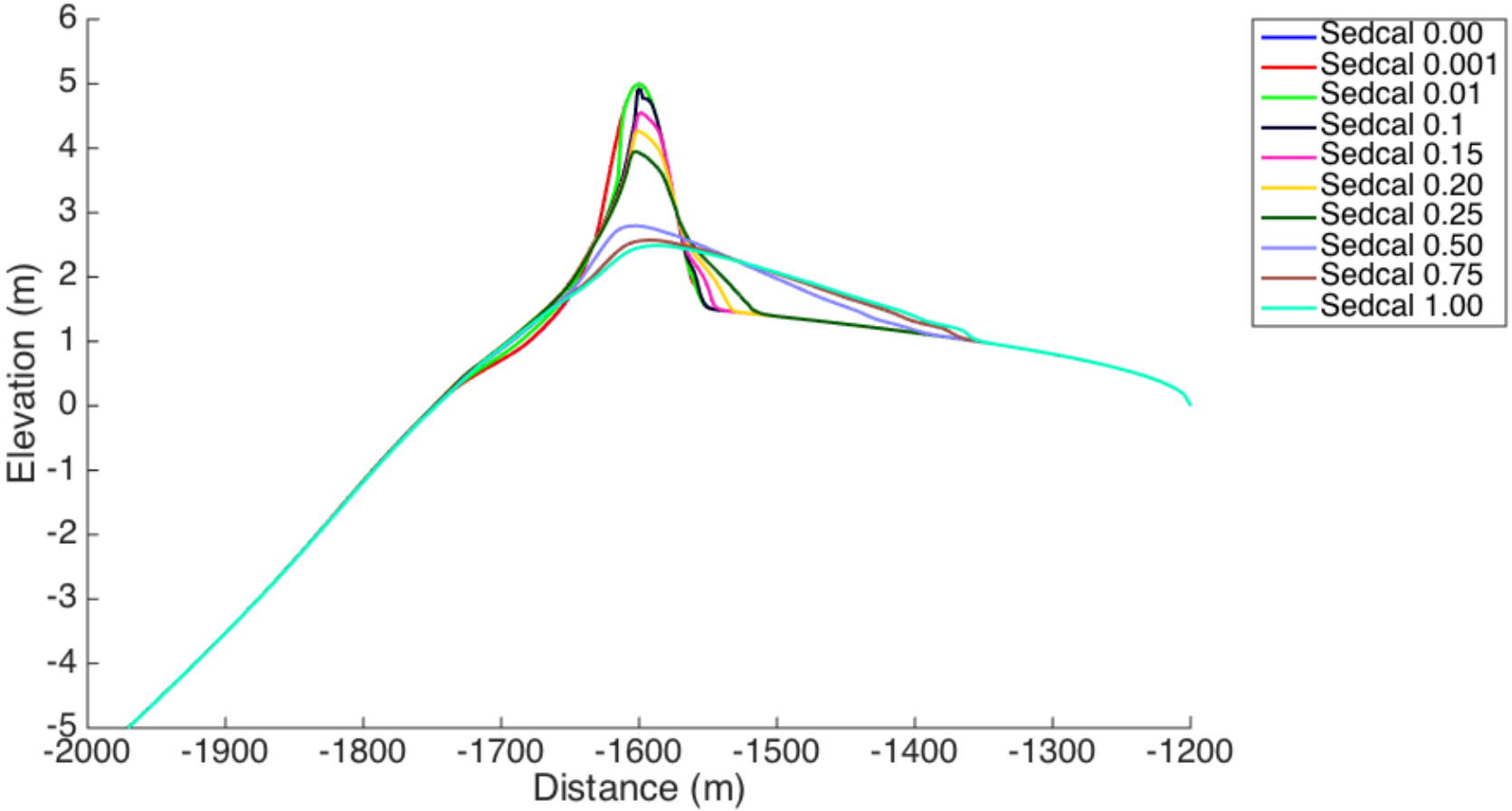
Results

- Berm width 75m:



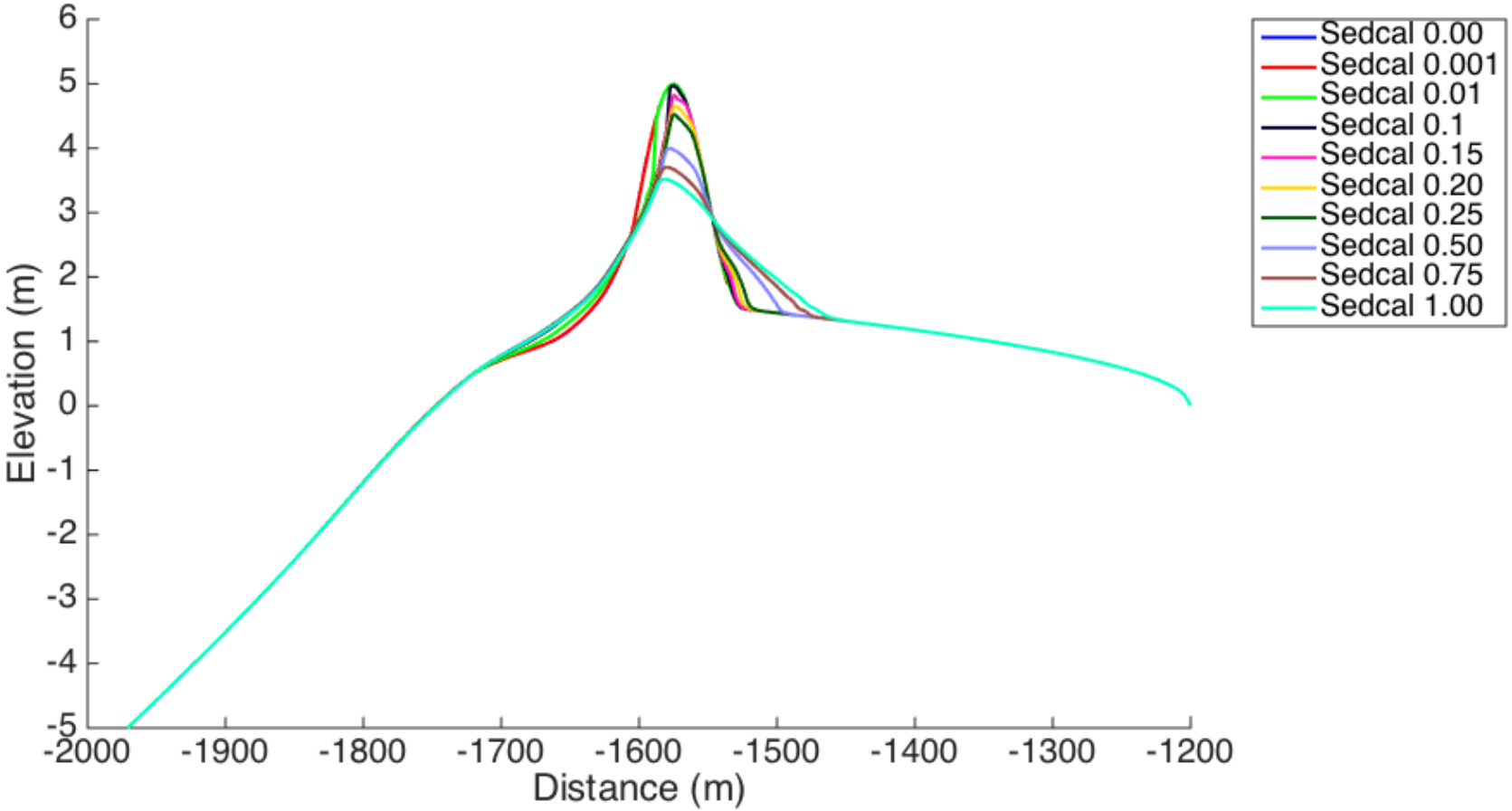
Results

- Berm width 100m:



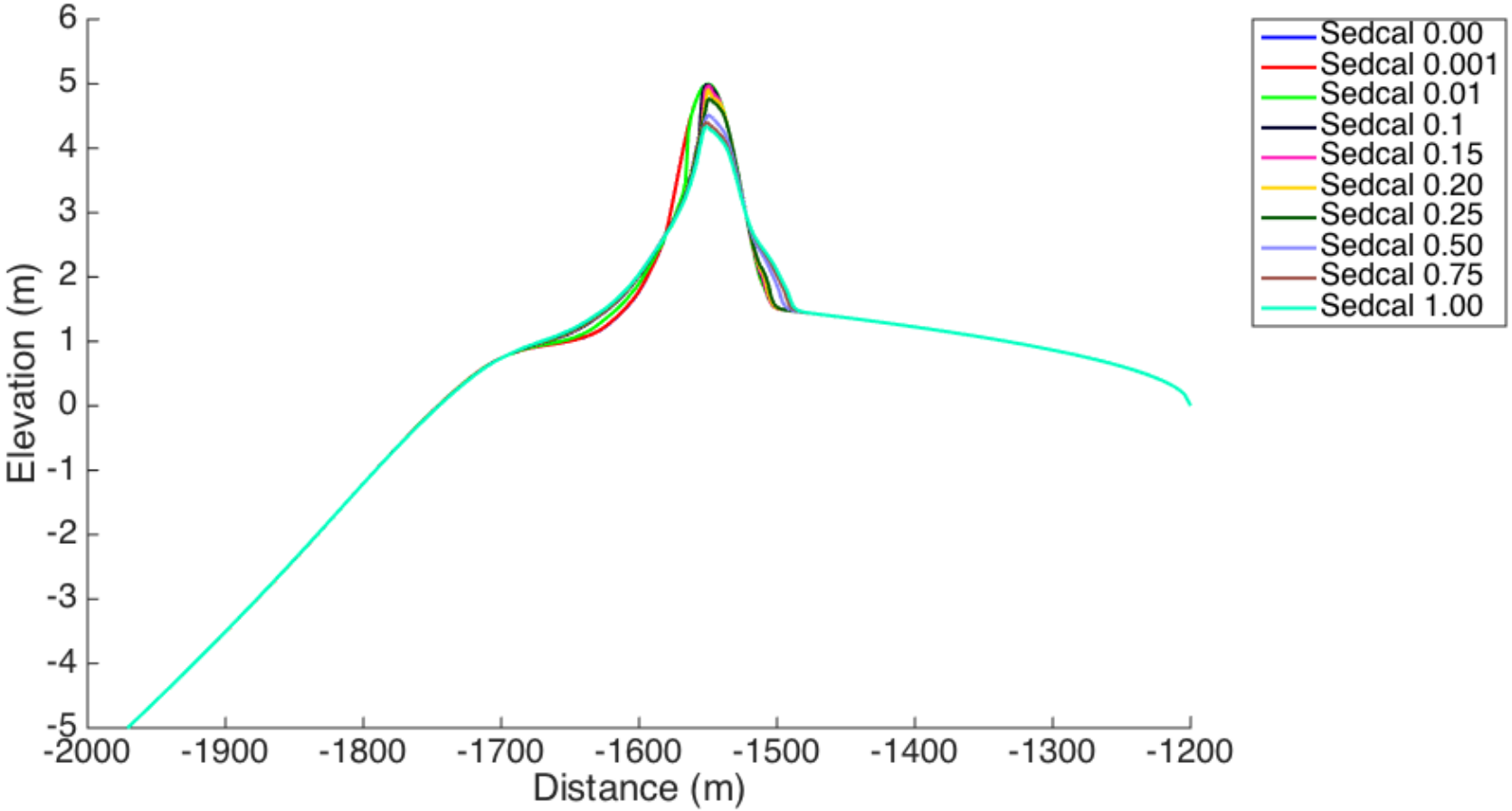
Results

- Berm width 125m:



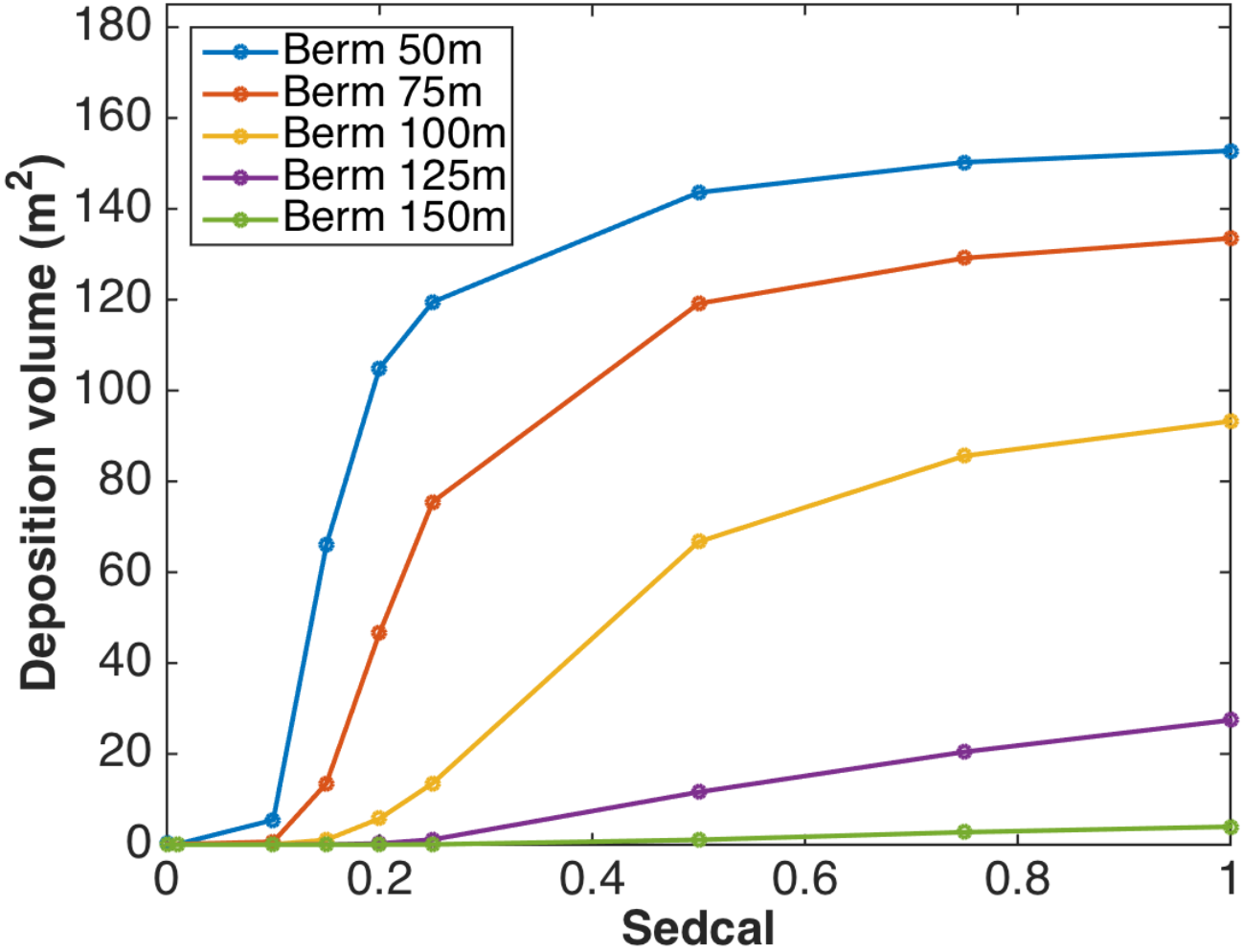
Results

- Berm width 150m:



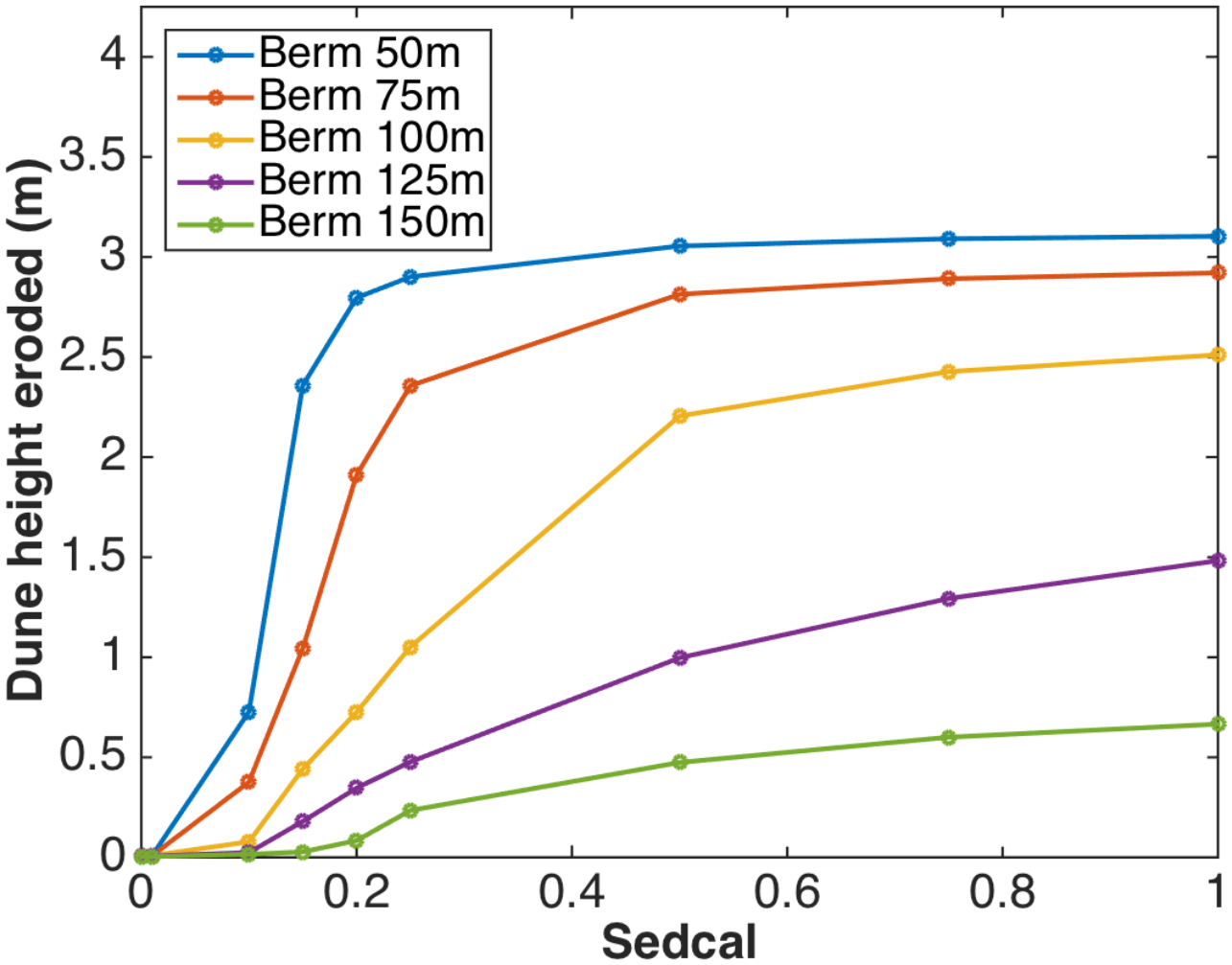
Results

- Overwash volume vs. sedcal



Results

- Dune erosion height vs. sedcal



Conclusions

- Wider berms result in less dune erosion and overwash volume.
- Larger sedcal parameters (strength of vegetation) result in less dune erosion.
- There exists a threshold berm width for a certain storm setup, beyond which sedcal has little influence.
- Similarly, there exists a threshold sedcal parameter, below which, berm width has little influnce.

Future work

- Expand parameter space:
  - Vegetation layer height
  - Dune height/width
  - Wave forcing
  - Surge level
- Utilize sediment bottom classification data, to establish the link between sedcal and vegetation strength/density.

Thank you !